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Effects of drought on child health in Marsabit District, Northern Kenya

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ABSTRACT

This study uses five years of panel data (2009–2013) for Northern Kenya's Marsabit district to analyze the levels and extent of malnutrition among children aged five and under in that area. We measure drought based on the standardized normalized difference vegetation index (NDVI) and assess its effect on child health using mid-upper arm circumference (MUAC). The results show that approximately 20 percent of the children in the study area are malnourished and a one standard deviation increase in NDVI *z*-score decreases the probability of child malnourishment by 12–16 percent. These findings suggest that remote sensing data can be usefully applied to develop and evaluate new interventions to reduce drought effects on child malnutrition, including better coping strategies and improved targeting of food aid.

1. Introduction

Weather-related shocks are a serious global threat that increasingly affect lives across the globe (Stern, 2006). Particularly in developing countries, people are most likely to suffer negative health outcomes as they tend to rely on locally produced food, lack access to proper health care, and are often in a vulnerable state of health even before experiencing weather shocks (Xu et al., 2012; FAO 2015). Yet whereas the health implications of such shock events as flooding, heat waves, and wildfires are relatively well studied, evidence for the more complex link between drought and health outcomes remains limited (Stanke et al., 2013). Nonetheless, many families depending on rural livelihoods remain vulnerable to extreme weather conditions and their negative effects, with drought risk at the forefront (Garnett et al., 2013; Dinkelman, 2015).

In developing countries, one population at particularly high risk for malnutrition and mortality is young children and infants, who suffer from worsening economic conditions (Pe'rez- Moreno et al., 2016) and are more vulnerable to weather shocks (Xu et al., 2012). Drought is found to lower health through two primary channels: insufficient food intake and weather-related diseases (Skoufias and Vinha, 2012). Already prenatal drought experience can affect the health of the yet unborn child (Grace et al., 2015). Effects of early age drought exposure and malnutrition are found to persist into adulthood, manifesting in growth retardation, disabilities, and lower earnings (Yamano et al., 2005; Alderman et al., 2006; Dinkelman, 2013; Rieger and Wagner, 2016; Puentes et al., 2016).

Child malnutrition is an important issue in the Marsabit district of Northern Kenya, in whose remote hotspots one of four children are malnourished (UNICEF, 2013; KNBS, 2015). This district, which is predominantly inhabited by pastoralists, is an arid region prone to frequent droughts that result in food shortages and hunger. Hence, this study analyzes the relation between drought and the nutritional status of children in Marsabit district. Specifically, the two main study objectives are to identify the levels of child malnutrition in the study area and to estimate the effects of drought on child health outcomes.

Although previous studies have addressed the relation between weather shocks and household food security (e.g. Xu et al., 2012; Stanke et al., 2013; Phalkey et al., 2015), much of this literature is hampered by relatively small sample sizes and its inability to identify causal relations (Phalkey et al., 2015). Furthermore, adverse drought-related health effects are sensitive to local coping mechanisms, drought intensity, health infrastructure, and individual characteristics (Brown et al., 2014). All of these factors differ among regions and cultures, thereby making it difficult to generalize previous findings. We contribute to the existing literature by using NDVI as a reliable measure of drought (Brown et al., 2014; Mude et al., 2009) in combination with five years of household panel data. An analysis of this particularly drought prone district provides valuable insights into the vulnerability of children to weather changes and the effectiveness of ongoing food aid programs in mitigating this relationship. Locally measured drought indicators are often incomplete (see e.g. Skoufias and Vinha, 2012) and missing data might correlate with local health

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Table 1
Descriptive statistics: child sample.

Variables	Full sample	Region			
		Central	Maikona	Loiyangalani	Laisamis
MUAC z-score	−1.04	−0.91	−0.93	−1.20	−1.17
Malnourished (=MUAC z-score < −2)[a]	17.8	15.8	12.7	21.6	22.3
NDVI z-score (long dry season average)	−0.31	−0.35	−0.28	−0.26	−0.36
Number of people in household	6.47	6.57	6.03	6.65	6.69
Dependency ratio in household[b]	1.62	1.48	1.47	1.75	1.87
Household head is male[a]	68.3	66.3	86.0	46.2	77.4
Age of household head in years	42.36	43.66	44.92	38.55	42.35
Education of household head in years	1.03	1.26	0.95	0.89	1.01
Household owns a phone[a]	41.2	56.5	44.2	36.4	23.4
Household has access to a toilet[a]	22.8	31.0	18.8	22.7	17.3
Child is male[a]	52.9	51.7	53.6	52.5	54.0
Age of the child in months	32.67	33.54	31.75	31.90	33.77
Child suffers from a chronic disease[a]	23.0	21.8	10.3	32.4	28.8
Household receives food aid[a]	14.1	18.7	13.9	13.6	8.8
Child receive supplemental feeding[a]	24.3	26.0	28.3	21.3	20.9
Number of TLUs	14.07	11.88	17.09	15.29	11.37
Herd diversity index[c]	0.37	0.33	0.41	0.32	0.43
Annual household income without aid (in 1000 Ksh)	138.6	115.3	144.5	162.7	129.5
Covered by livestock insurance[a]	13.4	15.0	14.6	8.9	16.1
Income diversity index[d]	1.55	1.99	1.34	1.49	1.31
# of observations	3302	882	872	889	659

Note: Values are based on the unweighted child means of the regression sample.
[a] Measured in percentages.
[b] Measured as household members under 15 and over 64 divided by the people between 15 and 64 years.
[c] Measured as the Shannon-Weiner Diversity Index.
[d] Measured as the Inverse Herfindahl Index.

conditions. We overcome this possible source of bias by using remote sensing data (NDVI) as a drought indicator. This allows estimating an indirect but (close to) causal effect of drought on child health, as we are able to account for unobservable characteristics that could potentially confound our estimates (Alfani et al., 2015).[1]

2. Study area and data description

The Marsabit district is characterized by an arid or semi-arid climate, droughts, poor infrastructure, remote settlements, low market access, and low population density. This area, which covers approximately 12 percent of the national territory, encompasses several ethnicities—including Samburu, Rendille, Boran, Gabra, and Somali—each with distinct languages, cultures, and customs. These pastoral communities live in semi-nomadic settlements in which livestock, the main source of livelihood, is moved across vast distances in search of grazing pastures, especially during the dry season (Fratkin et al., 2005). The study area can be divided into five broader regions based on similar agro-ecological conditions, herd composition, and climatic patterns (ILRI, 2012), where we have household data from four of those, namely Central, Maikona, Loiyangalani, and Laisamis.

The data for this study are taken from two different data sources: (i) NDVI remote sensing data, which proxy drought risk and (ii) Index-based Livestock Insurance (IBLI) child and household panel data, used to assess child health and regional variation.[2] The NDVI uses the intensity of photosynthetic activity to gauge the amount of vegetation cover within a given area (Tucker et al., 2005). We apply the NDVI data as they are highly exogenous to the household and community factors that affect child health and correlate directly with rainfall, which, in a pastoral context, reflects household food availability (Fensholt et al., 2006). Hence, the use of the NDVI is conceptually convincing and should clearly illustrate any effect of weather variability on child health. We transform the pure NDVI values to a z-score (for details, see Chantarat et al., 2012). Specifically, we use the average NDVI z-score values from the long dry season (June, July, August, and September) in each survey year, extracted for these four regions. The end of this dry season also coincides with the time of survey administration, which enables us to capture the levels of child wasting more accurately.

The panel data on child health and household characteristics are obtained from IBLI, which, starting in 2009, annually surveyed 924 households in Northern Kenya's Marsabit district with follow-ups conducted until the latest survey wave in 2013. These data were collected in 16 sublocations using a sample that was proportionally stratified based on the 1999 household population census. The data set contains a rich set of individual and household characteristics, including anthropometric data for children aged five and under.

3. Descriptive information

The descriptive statistics for both the whole sample and each of the four regions used in deriving the mean NDVI values over the entire survey period are given in Table 1. Results shows average MUAC z-score of less than −1 *SD*, with the situation in Loiyangalani and Laisamis being worse than in the Central or Maikona regions. The average proportion of malnourished children is approximately 18 percent but varies between 13 and 22 percent among the regions. As regards NDVI z-scores, the average indicates that overall, the weather conditions are worse than the 2000–2009 average, which was used to create the z-score, with an overall −0.31 *SD* lower greenness score. Although the Central and Maikona regions seem more developed, with more children living in households that own a phone or have access to sanitation, the share of families receiving public support is also higher in Central than in other regions, perhaps because its better infrastructure facilitates access.

Regarding income and wealth, we observe little differences between the regions. The average child in our sample lives in a

[1] An extended version of this article can be obtained as online appendix, http://dx.doi.org/10.1016/j.ehb.2016.10.010.
[2] http://data.ilri.org/portal/dataset/ibli-marsabit-r1.